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A Survey of Rare and Endangered Mayflies of Selected Rivers of Wisconsin

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Abstract

The mayfly fauna of 25 rivers and streams in Wisconsin were surveyed during 1991-93 to document the temporal and spatial occurrence patterns of two state endangered mayflies, *Acanthametropus pecatonica* and *Anepeorus simplex*. Both species are candidates under review for addition to the federal List of Endangered and Threatened Wildlife. Based on previous records of occurrence in Wisconsin, sampling was conducted during the period May-July using a combination of sampling methods, including dredges, air-lift pumps, kick-nets, and hand-picking of substrates.

No specimens of *Anepeorus simplex* were collected. Three specimens (nymphs or larvae) of *Acanthametropus pecatonica* were found in the Black River, one nymph was collected from the lower Wisconsin River, and a partial exuviae was collected from the Chippewa River. *Homoeoneuria ammophila* was recorded from Wisconsin waters for the first time from the Black River and Sugar River. New site distribution records for the following Wisconsin special concern species include: *Macdunnoa persimplex*, *Metretopus borealis, Paracloeodes minutus, Parameletus chelifer, Pentagenia vittigera, Cercobrachys* sp., and *Pseudiron centralis*. Collection of many of the aforementioned species from large rivers appears to be dependent upon sampling sand-bottomed substrates at frequent intervals, as several species were relatively abundant during only very short time spans. Most species were associated with sand substrates in water < 2 m deep. *Acanthametropus pecatonica* and *Anepeorus simplex* should continue to be listed as endangered for state purposes and receive a biological rarity ranking of critically imperiled (S1 ranking), and both species should be considered as candidates proposed for listing as endangered or threatened as defined by the Endangered Species Act. The three new distributional records for *A. pecatonica* in Wisconsin do not yet warrant a change in that species' global biological rarity ranking from critically imperiled (G1) to imperiled (G2). Extensive sampling of sand habitats is recommended in future mayfly studies and environmental assessments of large rivers in order to detect the presence of these and other relatively rare or elusive mayflies.

Cover photo: Field processing of samples on shore of the Wolf River at Langlade (June 1992). Photo by author.

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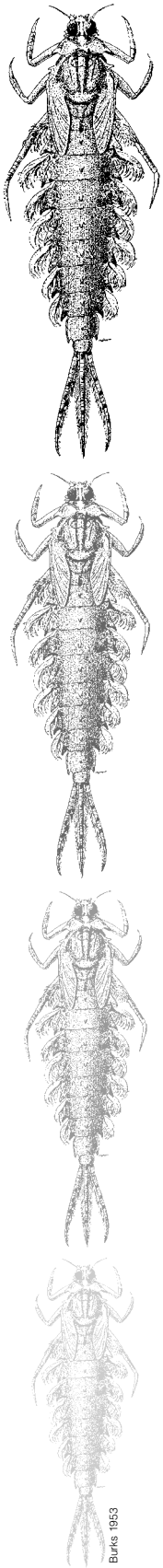


Acanthametropus pecatonica

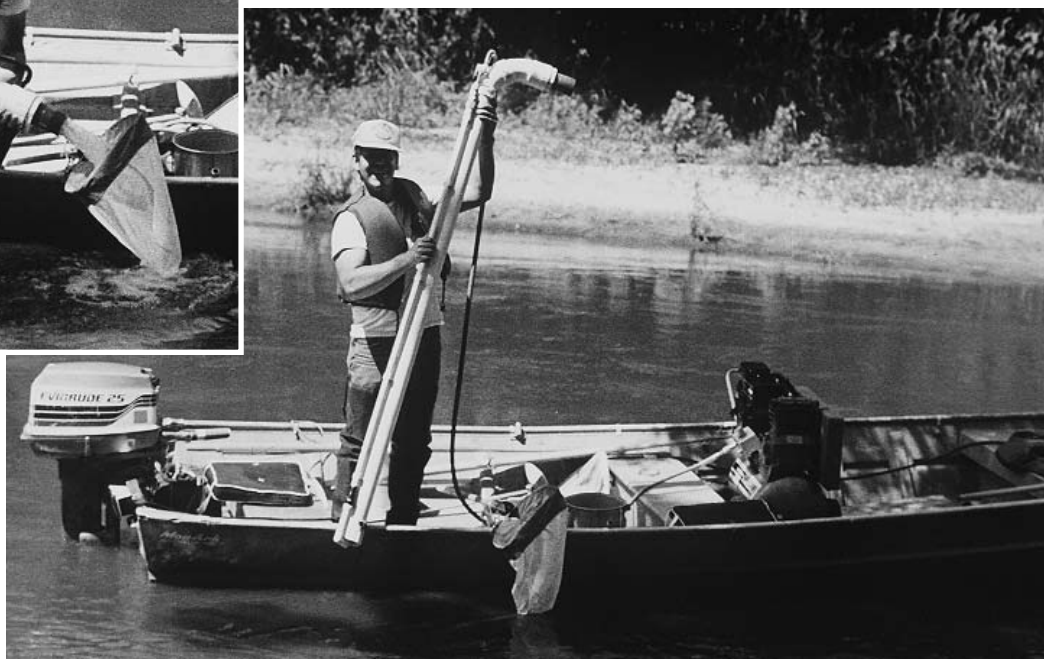
Introduction

Acanthametropus pecatonica (Burks) and *Anepeorus simplex* (Walsh) are relatively large, predatory mayflies (Ephemeroptera) belonging to the families Acanthametropodidae and Heptageniidae, respectively (McCafferty 1991, McCafferty and Provonsha 1988). Both species were added to the Wisconsin Endangered and Threatened Species List on 1 August 1989. Both species are currently listed by the Wisconsin Natural Heritage Inventory Program (WNHIP) and the Nature Conservancy (TNC) as critically imperiled in Wisconsin because of extreme rarity (state element ranking of S1), and both species are candidates under review for addition to the federal List of Endangered and Threatened Wildlife (Federal Register 1991). Consequently, their U.S. status for federal protection as designated by the Office of Endangered Species, U.S. Fish and Wildlife Service, is listed as C2. *Acanthametropus pecatonica* has a global element ranking of G1, indicating that the species is considered to be critically imperiled over its entire global range. *Anepeorus simplex* has a global ranking of G3G5, indicating that its global biological status is uncertain, ranging from possibly "demonstrably secure" to "vulnerable to extinction throughout its range." More complete descriptions of global and state element rankings as assigned by the WNHIP and TNC and "working lists" identifying species known or suspected to be rare in Wisconsin are available from the Wisconsin Department of Natural Resources (WDNR), Bureau of Endangered Resources, Madison, upon request.

Previous research and investigations documented the presence of *Acanthametropus pecatonica* and *Anepeorus simplex* in lower reaches of the Wisconsin River (Lillie et al. 1987, Lillie and Hilsenhoff 1992, Flowers and Hilsenhoff 1978 [*A. simplex* as *Spinadis* sp.]). The original specimens from which *Acanthametropus pecatonica* was described were collected from two tributaries of the Rock River in northern Illinois (Burks 1953), the Sugar and Pecatonica Rivers, both of which have their headwaters in southern Wisconsin. Most records indicated that the two species were collected from either sand substrates (*A. pecatonica*) or stable substrates over sand in deep water (*A. simplex*). Many rivers in Wisconsin contain similar habitats, but generally these habitats have been ignored or overlooked in mayfly faunal surveys, due to difficulties in sampling deep water or misperceptions related to the desert-like nature of sand-bottomed substrates. Consequently, we conducted an extensive survey of several selected large and relatively clean rivers with the primary objective to determine the status (i.e., the spatial and temporal distribution) of *A. pecatonica* and *A. simplex* in Wisconsin. We specifically directed our efforts at large rivers with sand bottoms, but we also included other rivers and streams with other types of habitats. Data on microhabitats, associated fauna, and estimates of population densities were also collected.

Figure 1. *Study sites. Numbers correspond to waterbody names in Table 1.*

An air-lift pump operated with a gas-powered compressor was used with a moderate amount of success to collect insects in deep-water areas of large rivers.



Compressed air, discharged just inside the opening of the sampling tube, rises within the tube, thus forcing water (and loose sediment and insects) up the tube and out the discharge end of the tube into a collection net.

PHOTOS: K. WEBSTER

Table 1. *Sample locations for mayfly survey of 1991-93. More detailed sampling location information may be obtained by contacting the author.*

Waterbody Name	No. Stations	No. Sampling Periods	Counties
1. Big Rib River	1	3	Marathon
2. Black River	3	7	LaCrosse, Trempealeau
3. Chippewa River	6	7	Dunn, Pepin, Rusk
4. Couderay River	1	2	Sawyer
5. Eau Claire River	1	3	Eau Claire
6. Eau Claire River	2	2	Marathon
7. Embarrass River	1	3	Waupaca
8. Flambeau River	6	3	Ashland, Rusk, Sawyer
9. Fox River	1	1	Green Lake
10. Jump River	3	3	Rusk, Taylor
11. Kickapoo River	1	1	Crawford
12. Mecan River	1	1	Marquette
13. Menominee River	4	2	Marinette
14. Oconto River	2	3	Oconto
15. Pecatonica River	3	3	Grant, Lafayette
16. Peshtigo River	2	2	Marinette
17. Rock River	2	2	Rock
18. St. Croix River	5	5	Burnett, Polk
19. Sugar River	3	7	Green, Rock
20. Trempealeau River	2	2	Trempealeau
21. Turtle Creek	1	1	Rock
22. Waukau Creek	2	1	Winnebago
23. White River	1	1	Green Lake
24. Wisconsin River	6	9	Columbia, Sauk, Grant, Richland
25. Wolf River	5	3	Langlade, Outagamie, Shawno, Waupaca

Methods

Synoptic surveys of mayfly fauna were conducted on 25 rivers and streams in Wisconsin during 1991-93 (Table 1, Fig. 1). Large rivers were selected for sampling due to their potential for harboring rare mayflies (McCafferty et al. 1990). Unfortunately, flooding prevented sampling of many of the large rivers during 1991 and 1993, thus prompting the substitution and sampling of several small streams. Most sampling was restricted to the period May-July to coincide with the observed occurrence pattern of *A. pecatonica* and *A. simplex* in Wisconsin (Lillie et al. 1987, Lillie and Hilsenhoff 1992). A variety of sampling gear was employed, including dredges, air-lift pumps, kick-nets, and hand-picking of substrates. Extensive efforts were made to sample sand-bottomed areas, which were suspected to be the primary habitat for the target species. All field samples were preserved in 95% ethanol until processed. Field notes recorded microhabitat conditions, such as current, substrate type, and depth at each site, and a limited number of physical-chemical measurements were also taken (Table 2). Mayflies were identified to genus based on keys in Hilsenhoff (1981) and to species based on keys in McCafferty (1975), Flowers (1982), Hilsenhoff (1982, 1984), Kondratieff and Voshell (1984), Pescador (1985), and Provonsha (1991). Taxonomy of the Baetidae follows that of McCafferty and Waltz (1990). Voucher specimens were preserved in 75% ethanol and are currently in the possession of the author, except for some specimens donated to the University of Wisconsin Insect Collection at UW-Madison and others donated to the Purdue University Insect Collection, West Lafayette, Indiana.

Table 2. *Observed ranges in limnological conditions at sampling locations listed in Table 1.*

Waterbody Name	Temperature (degrees F)	Conductivity (µmhos cm^{-1})	Alkalinity (mg L^{-1})	Clarity (inches)	Color (Units)	Turbidity (FTUs)
Big Rib River	59.0	93	–	B[a]	–	–
Black River	56.0-74.0	108-182	50-68	19.0-32.0	40-120	4.2-6.2
Chippewa River	55.0-77.0	90-125	39-53	23.5-37.0	50-70	1.9-5.1
Couderay River	50.0-65.0	104	50	B	45	2.4
Eau Claire River (Eau Claire Co.)	62.0-69.0	77-78	36	B	70	8.4
Eau Claire River (Marathon Co.)	59.0	82	–	B	–	–
Embarrass River	65.0	329	178	33.0-B	60	5.5
Flambeau River	53.5-70.0	54-97	32-42	B	60-70	2.1-2.5
Fox River	59.0	347	–	–	–	–
Jump River	69.0-74.0	111-174	57-74	B	50-80	1.2-3.8
Kickapoo River	62.0	463	–	17.4	–	–
Mecan River	59.0	204	–	B	–	–
Menominee River	59.5-67.0	204-276	102-113	B	60-70	1.6-3.0
Oconto River	63.0-70.0	241-264	129-143	B	50-80	2.0-4.3
Pecatonica River	65.0-68.0	552-613	284-290	7.0-8.5	50	18.0
Peshtigo River	59.5-66.0	208-216	129	B	70	1.1
Rock River	60.0	581-610	–	–	50	9.8
St. Croix River	57.0-75.5	95-135	54-71	30.0-B	50-70	1.3-2.7
Sugar River	57.0-73.0	529-670	269-290	8.0-22.0	25-60	11-22
Trempealeau River	–	–	–	B	–	–
Turtle Creek	74.0	693	–	B	20	7.2[b]
Waukau Creek	61.0	512	–	B	–	–
White River	–	–	–	B	–	–
Wisconsin River	60.0-77.0	133-249	100	14.0-28.5	40-55	3.0-5.3
Wolf River	59.0-69.0	239-323	136-153	20.0-31.0	45-70	3.4-5.8

[a] B = Secchi disk visible on bottom (all wadable streams).
[b] Runoff event in progress.

Results

General Findings

A total of 4,383 mayfly specimens, representing 86 taxa, was collected and identified (Table 3, Appendix A). Baetidae were the most common mayflies collected, both in terms of number of specimens (826) and number of taxa (20). Taxa richness was highest in the St. Croix River (51 taxa) (Table 3). However, in general, taxa richness was directly related to sampling effort. The number of mayfly taxa found in each river was positively correlated ($r^2 = 0.75$, $P < 0.0001$, linear regression analysis) with the number of specimens collected and examined. Associated caddisflies (Trichoptera) and beetles (Coleoptera) numbered 488 specimens (34 taxa) and 354 specimens (37 taxa), respectively (Appendixes B, C).

Distribution and Microhabitat of Targeted Species

No *Anepeorus simplex* specimens were collected during this study. All previous collections in Wisconsin have been from the Wisconsin River (early identifications were as *Spinadis*). These collections include four or five specimens from near the Orion boat landing in Richland County (Flowers and Hilsenhoff 1975, Flowers and Hilsenhoff 1978), one specimen from near Portage in Columbia County (Magnuson et al. 1977), two additional specimens in the University of Wisconsin Insect Collection from unknown locations on the Wisconsin River (UWIC, W. Hilsenhoff collector), one specimen from near the Port Andrew boat landing in Richland County (author's collection), and one specimen from near the Big Green River boat landing in Grant County (UWIC, K. Schmude collector).

Four *Acanthametropus pecatonica* nymphs and one exuviae were collected from three rivers during the current survey. Single specimens of *Acanthametropus pecatonica* were found in the Black River (nymph) and Chippewa River (partial exuviae only)

Table 3. *Summary of insects collected during 1991-93. Data are ranked in order of total number of mayflies collected. Numbers in parentheses represent number of distinct taxa in each river. (Inasmuch as some specimens within a number of genera could not be identified to the species level due to the lack of adequate keys, the taxa richness reported here should be regarded as a minimum).*

Waterbody Name	Mayflies	Caddisflies	Beetles	Unique Taxa	Common Taxa
Wisconsin River	641 (32)	97 (9)	41 (13)	6	28
St. Croix River	590 (51)	99 (19)	130 (17)	9	36
Sugar River	506 (28)	26 (8)	12 (7)	1	17
Black River	481 (36)	54 (9)	22 (8)	5	28
Chippewa River	344 (34)	26 (13)	6 (3)	2	16
Flambeau River	295 (34)	20 (8)	20 (9)	2	16
Menominee River	286 (28)	14 (8)	26 (8)	0	13
Wolf River	259 (35)	30 (16)	21 (13)	8	15
Pecatonica River	191 (12)	6 (1)	6 (4)	0	6
Oconto River	144 (20)	7 (6)	12 (3)	1	8
Jump River	76 (18)	4 (3)	10 (7)	5	3
Eau Claire River (Eau Claire Co.)	71 (16)	9 (7)	0 (0)	1	6
Eau Claire River (Marathon Co.)	62 (17)	7 (6)	6 (5)	1	1
Embarrass River	57 (16)	12 (7)	4 (2)	0	4
Peshtigo River	54 (20)	13 (8)	17 (4)	0	4
Turtle Creek	54 (8)	16 (6)	8 (3)	0	5
Couderay River	51 (10)	5 (5)	3 (3)	1	3
Big Rib River	47 (10)	3 (2)	0 (0)	0	2
Trempealeau River	42 (13)	3 (3)	0 (0)	0	2
Rock River	41 (5)	4 (3)	1 (1)	0	1
Kickapoo River	34 (7)	8 (4)	2 (2)	1	2
Waukau Creek	22 (2)	5 (3)	1 (1)	2	1
Mecan River	14 (4)	11 (9)	6 (2)	2	2
Fox River	12 (3)	7 (4)	0 (0)	0	1
White River	9 (4)	2 (2)	0 (0)	1	0

in 1991. Both specimens were found within a 2-day period (Table 4) in similar habitats consisting of large, sand-bottomed rivers. The former specimen (Black River) was found in a strong, sand-bottomed eddy in water about 1 m deep, while the latter (Chippewa River) specimen was collected in the drift, above sand and fine gravel in moderately fast current (estimated 0.50-1.0 m sec^{-1}) in water < 1 m deep. The Black River specimen was a very small nymph (5 mm) and, as a result, was not immediately recognized as *Acanthametropus*. The Chippewa River specimen, although only a partial exuviae, was recognized in the field as being unusual by its size and shape, but was assumed to be an *Isonychia* until it was observed under magnification. Two additional specimens of *A. pecatonica* were collected from the Black River in 1992 from a site < 1 km upstream from where the 1991 specimen was taken. The two specimens were collected within a few meters from one another in water about 1 m deep over a bottom substrate consisting of fine silt over sand. Attempts to rear these individuals in the laboratory failed, although one specimen lived long enough to reach final instar stage (the exuviae is included in tally in Appendix A and Table 3). A single specimen was collected from the lower Wisconsin River in 1992 within a few meters of where the first Wisconsin specimen was collected in 1986 (Lillie et al. 1987). This site is best characterized as a run of moderate current (approximately 0.5-1.0 m sec^{-1}) with shifting sand bottom. Maximum water depth was approximately 1 m. Previous to this study, the author collected 14 specimens (including 3 exuviae) of *A. pecatonica* from the same vicinity during the period 1986-1990.

Limnological conditions present in the three rivers where *A. pecatonica* occurred are moderately fertile and otherwise intermediate between pristine and

Sandbar habitat near the Big Green River boat landing on the Lower Wisconsin River (Grant Co.). Site of multiple collections of A. pecatonica*. Photo taken May 1991.*

Collection site of A. pecatonica *on the Black River (Trempealeau Co.). Photo taken June 1992.*

heavily impacted rivers in Wisconsin; all receive wastewater treatment effluents some distance upstream from collection sites. Surrounding riparian cover generally consisted of floodplain forest with birch, elm, maple, and willows predominating. All three rivers have predominantly sand substrates with wide channels (100-500 m) and occasionally high sandy banks.

Population Density of Targeted Species

No estimates of population density (on an areal basis) for either species of interest were derived due to the low abundances and frequencies of occurrence encountered. Although I have collected as many as five specimens of *A. pecatonica* in one D-frame net haul from the lower Wisconsin River in 1990 (unpubl. data), specimens collected in this study required extensive effort to obtain and were widely spaced (albeit the two 1992 specimens from the Black River were collected about 30 minutes apart within a few meters of one another). Estimates on a catch per unit effort basis (per person) for *A. pecatonica* are: Wisconsin River—2 hours/specimen, Black River—4 hours/specimen, and Chippewa River—> 8 hours/specimen. These estimates are valid only for the narrow time window, late May-early June, at the specific sites where *A. pecatonica* has been collected. Only the Wisconsin River and Black River populations should be considered viable populations.

Associates of Targeted Species

Mayfly species most frequently occurring with *A. pecatonica* in this survey include *Brachycercus* spp., *Cercobrachys* spp. Soldan, and *Pseudiron centralis* McDunnough. Lillie and Hilsenhoff (1992)

PHOTOS: R. LILLIE

One exuviae of A. pecatonica *was taken at this site on the Chippewa River (Pepin Co.). Photo taken June 1992.*

Sampling a rocky run at Port Andrew boat landing (Richland County) on the Lower Wisconsin River - a site where Anepeorus simplex *had been collected prior to this survey.*

found the corixid *Sigara lineata* (Forster) and various chironomids, including *Glyptotendipes* spp. and *Polypedilum* spp., to occupy similar habitats as *A. pecatonica*. Chironomids are believed to be the major food item in the diets of both species (Flowers and Hilsenhoff 1978, McCafferty 1991). No associates were clearly identifiable among the caddisflies or beetles collected in conjunction with this survey.

Other Mayfly Records

Several occurrences of other mayflies have significance to Wisconsin because of their perceived rarity (Table 4). All of the following mayflies are currently listed as species of special concern for Wisconsin. *Pentagenia vittigera* (Walsh) was found in mud-clay banks on the Sugar River, Wolf River, and Pecatonica River. *Homoeoneuria ammophila* (Spieth) was found in abundance, buried in sand, on the Black River and Sugar River in 1991. (Only one specimen was collected from the Sugar River during 1992 from the same habitat, despite intensive searching.) *Metretopus borealis* Eaton was collected adjacent to large eddies over sand in the Chippewa River and Black River. Single specimens of *Macdunnoa persimplex* (McDunnough) were found in the St. Croix River and Chippewa River. *Paracloeodes minutus* (Daggy) was captured from the Wolf River, and *Parameletus chelifer* Bengtsson was collected in the Wolf River and the St. Croix River. Several specimens of what appear to be the same species of *Cercobrachys* Soldan (the key to species of this genus by Soldan [1986] contains contradictions that make it impossible to key our specimens) and several *Pseudiron centralis* McDunnough, a large predaceous mayfly, were obtained from sand or silt substrates in most rivers that were sampled intensively.

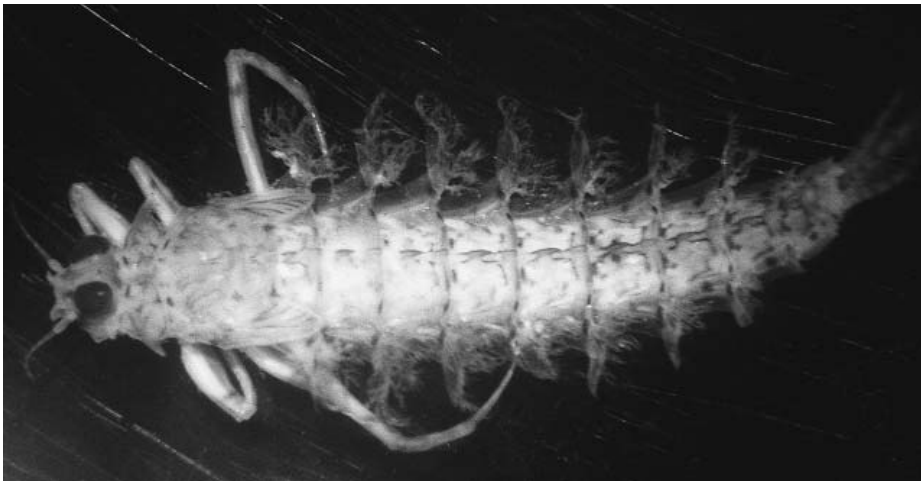
Table 4. *Summary of rare, threatened, endangered, or special concern species of mayflies discovered in the 1991-93 survey of 25 Wisconsin rivers and streams.*

Taxa	No. Specimens	Stage	County	River	Date	Location	Town-Range-Section
Anepeorus simplex	0						
Acanthametropus pecatonica	1	nymph	Trempealeau	Black	10 June 91	near Hwy 35 landing	T18N R 8W SEC28
	1	exuviae	Pepin	Chippewa	11 June 91	above Durand	T25N R13W SEC16
	1	nymph	Grant	Wisconsin	5 June 92	near Big Green River landing	T7N R4W SEC15
	2	nymphs	Trempealeau	Black	11 June 92	upriver Hwy 35	T18N R8W SEC28
	1	exuviae (from one of two nymphs above)					
Homoeoneuria ammophila	26	nymphs	Trempealeau	Black	16 July 91	1 mile upriver Hwy 35	T18N R8W SEC28
	48	nymphs	Rock	Sugar	10 July 91	Nelson Rd. area	T1N R10E SEC27-28
	1	nymph	Rock	Sugar	6 July 92	Nelson Rd. area	T1N R10E SEC27-28
Macdunnoa persimplex	1	nymph	Burnett	St. Croix	12 June 91	1 mile upriver Hwy 70	T38N R20W SEC13
	1	nymph	Dunn	Chippewa	15 June 92	Dunnville Bottoms	T26N R12W SEC3
Metretopus borealis	37	nymphs	Pepin	Chippewa	21 May 91	near Hwy N boat landing	T24N R14W SEC23
	5	nymphs	Dunn	Chippewa	3 June 93	Fishrooke Rd access	T26N R11W SEC5
	1	nymph	Trempealeau	Black	11 June 92	above Hwy 35	T18N R8W SEC28
Pentagenia vittigera	12	nymphs	Green	Pecatonica	7 June 91	near Martintown	T1N R6E SEC32
	1	nymph	Rock	Sugar	10 July 91	upriver Nelson Rd.	T1N R10E SEC28
	1	nymph	Rock	Sugar	4 June 92	Nelson Rd. bridge	T1N R10E SEC27
	1	nymph	Rock	Sugar	6 July 92	Nelson Rd. bridge	T1N R10E SEC27
	1	nymph	Waupaca	Wolf	9 June 92	above Dey Rd. access	T22N R14E SEC15-16

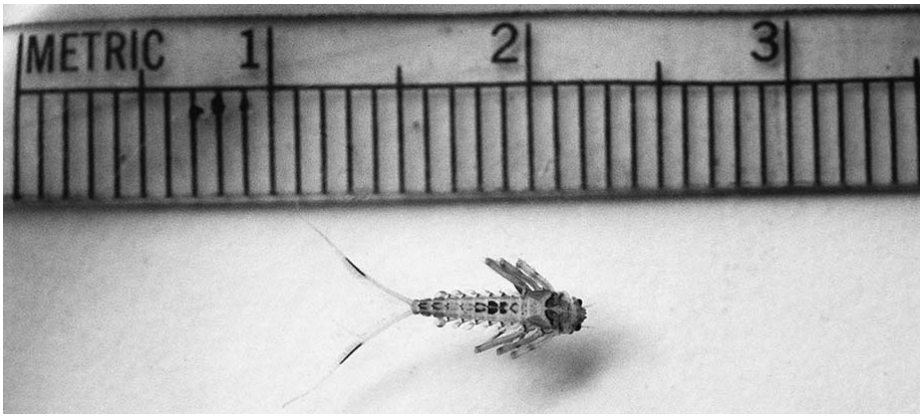
Table 4. *Continued.*

Taxa	No. Specimens	Stage	County	River	Date	Location	Town-Range-Section
Paracloeodes minutus	1	nymph	Shawno	Wolf	15 July 92	Hwy CCC boat landing	T26N R16E SEC29
Parameletus chelifer	2	nymphs	Burnett	St.Croix	6 May 92	Seven Island area	T39N R19W SEC29
	9	nymphs	Outagamie	Wolf	6 May 93	Shiocton - below Hwy 54	T23N R16E SEC29
Pseudiron centralis	81	nymphs	Rock & Green	Sugar	May-June 91-92	Avon W.A. near Nelson Rd. to Hwy 11 near Brodhead	multiple locations
	24	nymphs	Trempealeau	Black	May-June 91-92	Hwy 35 boat landing & upstream Hwy 35	multiple locations
	8	nymphs	Burnett	St. Croix	12 June 91	Cliff area above Hwy 70	T38N R19W SEC7
	3	nymphs	Pepin	Chippewa	21 May 91	Hwy N to Durand	multiple locations
	20	nymphs	Grant	Wisconsin	May-June 92	near Big Green River to Blue River	multiple locations
	3	nymphs	Waupaca	Embarrass	14 May 92	Benthke Rd. near Clintonville	T25N R15E SEC17
	14	nymphs	Trempealeau	Trempealeau	11 June 92	at Dodge	T19N R6W SEC10
Cercobrachys sp.[a]	23	nymphs	Grant	Wisconsin	June-Aug 91-93	Millville to Eagle Pt.	multiple locations
	27	nymphs	Burnett	St. Croix	June-July 91-92	Hwy 70 to 7-Island area	multiple locations
	96	nymphs	Rock & Green	Sugar	June-July 91-92	Nelson Rd. to Hwy 11	multiple locations
	45	nymphs	Trempealeau	Black	June-July 91-92	upriver Hwy 35	T18N R8W SEC 28
	14	nymphs	Pepin & Rusk	Chippewa	July 91-92	upriver Hwy 35 and above confluence with Flambeau River	multiple locations
	4	nymphs	Trempealeau	Trempealeau	11 June 92	at Dodge	T19N R6W SEC10
	1	nymph	Green	Pecatonica	6 July 92	upriver Martintown	T1N R6E SEC32

[a] Taxonomy of *Cercobrachys* sp. is questionable at species level.

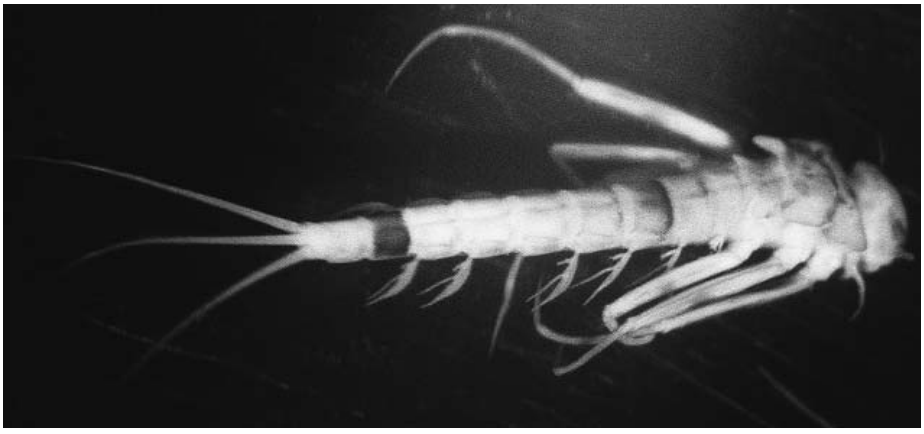


Acanthametropus pecatonica
(actual size = 17 mm)



Anepeorus simplex
(actual size = 6.5 mm)

Metretopus borealis
(actual size = 10.5 mm)



Pseudiron centralis
(actual size = 11.5 mm)

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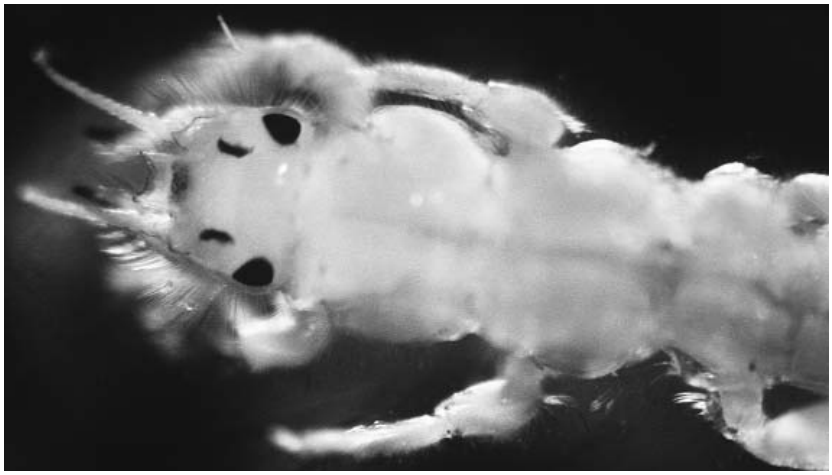
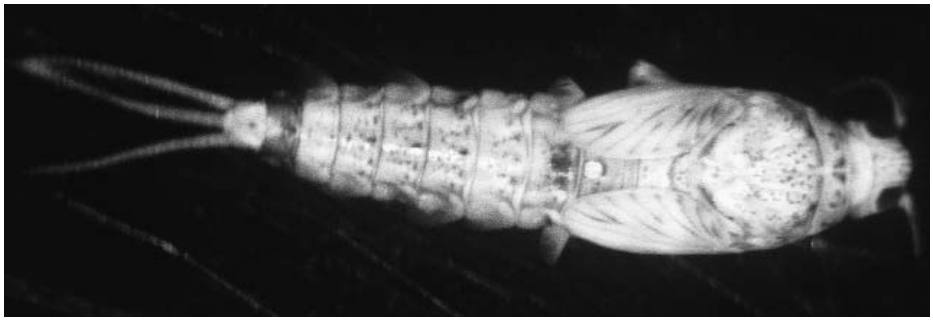
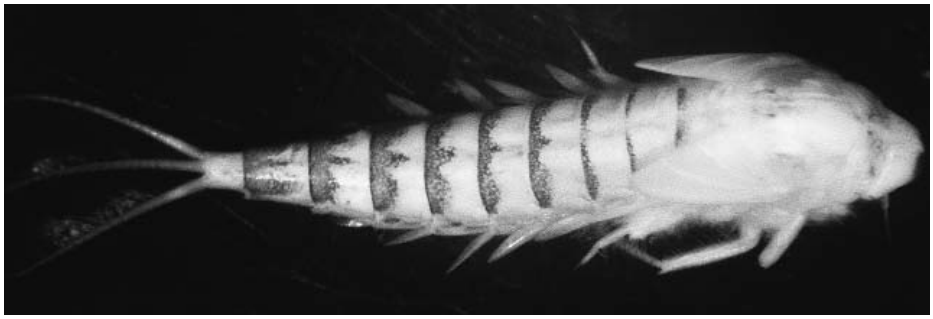
Parameletus chelifer
(actual size = 10 mm)



Pentagenia vittigera
(actual size = 10 mm)



Paracloeodes minutus
(actual size = 3.4 mm)



Homoeoneuria ammophila
(actual size = 6 mm)

Discussion

Targeted Species

In terms of project objectives, the survey was moderately successful. Although no specimens of *A. simplex* were found, specimens of *A. pecatonica* were discovered in the Black River (3 nymphs) and Chippewa River (1 exuviae). Together with its continuing occurrence in the lower reaches of the Wisconsin River (1 nymph this study), *A. pecatonica* is now known to occur in three rivers in Wisconsin (a total of 15 specimens since 1986, all in the Mississippi River drainage basin). The expanded distribution records for *A. pecatonica* do not justify modification of its current status as critically imperiled in Wisconsin (S1) because less than 6 viable populations have been documented or are likely to occur. The three Wisconsin occurrence records, combined with the disjunct occurrences from the Flint River in Georgia and the Savannah River in South Carolina (McCafferty 1991), bring the known total occurrence record for *A. pecatonica* in North America to five. The population in the Rock River system of Illinois (collected in 1927) (Burks 1953) and Wisconsin may have been extirpated. This is supported by the lack of specimens in our extensive collections of the Pecatonica River and Sugar River of Wisconsin during the present study and the lack of specimens during an intensive survey of the Pecatonica River basin by staff of the Illinois Environmental Protection Agency in 1984-85 (Illinois EPA 1988). Therefore, until other populations of *A. pecatonica* are documented, our discoveries of at least two viable populations in Wisconsin do not warrant a change in global biological ranking of critically imperiled (G1) to simply imperiled (G2 requires 6 to 20 viable occurrences). The status of *A. simplex* should continue to be listed as critically imperiled in Wisconsin (S1) and global status should continue to be listed as uncertain (G3G5). Continued sampling of the large, sand-bottomed rivers in Wisconsin and adjacent states is recommended to further document the range and life cycle of these rare species. Flooding, as discussed in the methods section, may have interfered with our ability to detect the target species in some rivers. *Anepeorus simplex*, in particular, may have been missed due to the high water because it appears to prefer deep, fast, water habitats.

Other Mayfly Collections

Aside from the targeted species, several other significant collections were recorded. Table 4 summarizes the dates and locations of these collections. *Homoeoneuria ammophila* was recorded for Wisconsin waters for the first time. Single specimens of *Macdunnoa persimplex* from the St. Croix and Chippewa rivers represent only the fourth and fifth specimen records, respectively, for Wisconsin; the other three records are from the Lower Wisconsin River (Lillie and Hilsenhoff 1992). The specimen of *Metretopus borealis* from the Black River represents the second distribution record for Wisconsin (previously reported only from the Chippewa River, pers. comm., W. Hilsenhoff, UW-Madison). *Pentagenia vittigera*, typically a large river species, had been collected only twice in Wisconsin previous to this study (one specimen from the Wisconsin River per Lillie and Hilsenhoff 1992). *Paracloeodes minutus* had been collected previously only from the Wisconsin River (Lillie and Hilsenhoff 1992, Mead & Hunt, Inc. 1993). The only previous record of *Parameletus chelifer* in Wisconsin was from the St. Croix River (pers. comm., W. Hilsenhoff). *Cercobrachys* sp. and *Pseudiron centralis* had been collected only from the Wisconsin River prior to 1991. The relative rarity of *Homoeoneuria ammophila, Metretopus borealis, Paracloeodes minutus, Parameletus chelifer, Pentagenia vittigera*, and *Macdunnoa persimplex* in Wisconsin collections justify the possible classification of these species as proposed state threatened (PTHR) or proposed endangered (PEND) and assignment of protection priority rating as critically imperiled (S1). *Pseudiron centralis* and *Cercobrachys* sp. are obviously more common than previously believed and, consequently, should be listed as imperiled in Wisconsin (S2).

Biological Significance

The success of this survey with respect to collecting relatively rare mayflies (rarity with regard to both national distributional occurrences and state records) is highly significant and may impact several programs related to aquatic resource management. The expanded distribution records for *A. pecatonica* to three Wisconsin rivers nearly equals the total number of other rivers from which this elusive species has been collected nationwide (see McCafferty 1991). The new collection records of several rarely encountered mayflies emphasizes the need for conducting a thorough inventory of aquatic resources of our larger river systems. Representation in collections is one of several factors considered in determining the status of

aquatic insect species for biological ranking and ultimately for designation on the state's Threatened and Endangered Species List; sampling effort and habitats inventoried are also considered. Currently, rankings are assigned to each species based on estimated viable occurrences, and final determinations are made by Natural Heritage Programs in consultation with knowledgeable experts (pers. comm., T. Vogt and W. Smith, WDNR, Madison). Therefore, our knowledge of the distribution of many aquatic insects and their subsequent rankings may be influenced by sampling strategies and previous collection efforts. Inasmuch as inventories of aquatic habitats have been weighted towards sampling rocky riffle areas or snags, generally thought to harbor the greatest species diversity and abundance (Cuffney et al. 1993), and away from wide expanses of sand-bottomed substrates, our knowledge of all aquatic resources inhabiting the latter areas is severely limited. Prior to the author's collection of *A. pecatonica* on 7 June 1986 in the Lower Wisconsin River, *A. pecatonica* had not been seen in the Upper Midwest since 1927 and was believed to have been extirpated (Lillie et al. 1987). The rediscovery of *A. pecatonica* after a period of 59 years begs the question as to where this organism has been all these years. It is unlikely that *A. pecatonica* has spread into Wisconsin from a refuge in the Southeastern United States (broadly disjunct populations in Georgia and South Carolina). It is more likely that *A. pecatonica* was not extirpated, but rather that it is rare in collections because people have not searched in the right location at the right time with the right equipment. The recent discoveries of *Dolania americana* Edmunds and Traver in the St. Croix River (Jacobs 1990) and two new species of *Ophiogomphus* (Odonata: Gomphidae) (Vogt and Smith 1993; pers., comm. K. Tennesson, Muscle Shoals, Alabama, and T. Vogt, Stockton, Illinois) in northwestern Wisconsin further support this tenet. The commonality in distribution of several rare, sand-loving (psammophilous) mayflies may be the consequence of the difficulties involved in sampling their habitat (deep, sandy, large rivers) combined with the insects' behavior (fast swimmers; see Barton and Smith 1984, McCafferty 1991). *Anepeorus simplex* has a somewhat broader distribution, but it also has been restricted to large, deep, sand-bottomed rivers, albeit often on rocks or other substrates over sand. Although these two endangered mayfly species may actually be more common than records indicate, more studies are necessary to document the true extent of their ranges and life cycles. Likewise, it is important that clean, large, sand-bottomed rivers be protected from further exploitation (McCafferty 1991).

Management Summary

Until more is known of the life history requirements of these two species, the state status of both *Acanthametropus pecatonica* and *Anepeorus simplex* should be maintained as endangered. The three distribution records of *A. pecatonica* for Wisconsin do not, by themselves, warrant a change in global ranking status from critically imperiled (G1) to imperiled (G2). Environmental impact assessments and surveys of large rivers should include efforts to sample sand substrates in both erosional and depositional areas during the period of late May to mid-June to maximize the opportunity to detect these two, relatively elusive, species.

Homoeoneuria ammophila, Macdunnoa persimplex, Metretopus borealis, Pentagenia vittigera, Paracloeodes minutus, and *Parameletus chelifer* warrant classification as proposed state threatened (PTHR) or endangered (PEND) and assignment of protection priority rating as critically imperiled (S1). The status of *Pseudiron centralis* should be listed as imperiled in Wisconsin (S2). The status of *Cercobrachys* sp. is uncertain. Until taxonomic problems can be resolved and identifications verified, all species of this genus in Wisconsin (there may be more than one) should be listed as species of Special Concern.

The mayfly fauna of many rivers and streams in Wisconsin have never been explored, and most large rivers have received only a cursory examination. Mayflies are important water quality indicators; knowledge of their distribution and environmental requirements are important for assessing the biological integrity of the state's waters. The same may be said for other aquatic macroinvertebrate orders. Statewide inventories of all aquatic resources should be given the highest priority to ensure an adequate data base for making future water management decisions. Until more complete inventories of aquatic resources can be completed, all reaches of the larger river systems in Wisconsin should be afforded the highest degree of protection possible.

Appendix A. *Distribution of Ephemeroptera (mayflies) collected during 1991-93, by river.*

Family *Genus-species*	Total	Wisconsin R.	St. Croix R.	Sugar R.	Black R.	Chippewa R.	Flambeau R.	Menominee R.	Wolf R.	Pecatonica R.
Acanthametropodidae										
Acanthametropus pecatonica	6	1	0	0	4	1	0	0	0	0
Baetida										
Acentrella carolina	10	0	4	0	0	0	0	0	0	0
Acerpenna pygmaea	15	0	2	0	0	0	0	2	2	0
Baetis armillatus	11	0	1	1	1	2	0	1	2	0
Baetis brunneicolor	24	4	0	7	5	2	0	0	0	0
Baetis caelestis	1	0	0	0	1	0	0	0	0	0
Baetis cinctutus	4	0	2	0	0	1	0	0	0	0
Baetis dubius	100	2	15	7	26	21	10	1	4	0
Baetis flavistriga	73	0	11	5	1	6	10	5	10	0
Baetis frondalis[a]	7	0	7	0	0	0	0	0	0	0
Baetis intercalaris	67	2	3	2	7	0	23	9	7	0
Baetis longipalpus[a]	119	115	0	0	4	0	0	0	0	0
Baetis propinquus[a]	116	29	24	0	10	4	4	8	6	3
Baetis punctiventris	23	0	1	0	0	1	4	0	8	0
Baetis sp.	1	0	0	0	0	0	0	0	0	0
Baetis tricaudatus	7	0	2	0	0	0	0	0	0	0
Callibaetis sp.	11	1	1	0	0	1	0	0	0	0
Centroptilum/Procloeon sp.	216	59	14	4	29	21	16	1	20	0
Heterocloeon curiosum	1	0	1	0	0	0	0	0	0	0
Paracloeodes minutus	1	0	0	0	0	0	0	0	1	0
Pseudocloeon/Baetis sp.	11	3	1	1	0	0	0	0	0	0
Pseudocloeon/Baetis sp. A	8	0	0	0	0	0	0	0	0	0
Baetiscidae										
Baetisca lacustris	111	46	5	13	2	35	0	0	0	4
Baetisca laurentina	53	0	1	0	3	3	13	2	1	0
Baetisca obesa	57	16	16	0	4	3	0	18	0	0
Baetisca sp.	1	0	0	0	0	0	0	0	0	0
Caenidae										
Brachycercus sp.	231	51	38	1	67	37	5	0	11	0
Caenis amica	1	1	0	0	0	0	0	0	0	0
Caenis anceps	1	0	0	0	0	0	0	0	0	0
Caenis diminuta	1	1	0	0	0	0	0	0	0	0
Caenis hilaris	3	2	1	0	0	0	0	0	0	0
Caenis latipennis	55	30	6	0	0	2	0	1	0	0
Caenis sp.	125	9	1	9	9	3	4	37	34	3
Caenis youngi	1	0	1	0	0	0	0	0	0	0
Cercobrachys sp.	210	23	27	96	45	14	0	0	0	1
Ephemeridae										
Ephemera simulans	21	0	0	0	0	0	12	4	1	0
Hexagenia atrocaudata(?)	5	0	0	0	0	0	0	0	5	0
Hexagenia bilineata	21	0	0	2	1	0	0	0	2	15
Hexagenia limbata	242	3	7	38	7	0	1	29	5	131
Hexagenia sp.	2	0	0	0	2	0	0	0	0	0
Pentagenia vittigera	16	0	0	3	0	0	0	0	1	12
Heptageniidae										
Epeorus sp.	5	0	5	0	0	0	0	0	0	0
Epeorus vitreus	10	0	0	0	0	0	1	0	3	0
Heptagenia diabasia	17	1	0	1	4	6	0	0	0	4
Heptagenia flavescens	33	29	0	2	1	0	0	0	0	0
Heptagenia pulla	12	0	0	2	10	0	0	0	0	0
Leucrocuta hebe	143	0	30	19	0	26	17	5	3	0
Macdunnoa persimplex	2	0	1	0	0	1	0	0	0	0
Nixe lucidipennis	1	0	0	0	1	0	0	0	0	0
Rhithrogena jejuna	3	0	0	0	0	0	0	0	1	0
Rhithrogena pellucida	1	0	0	0	0	0	0	0	0	0
Rhithrogena sp.	37	0	37	0	0	0	0	0	0	0
Stenacron interpunctatum	58	2	2	1	0	0	3	12	0	7

(continued on next page)

Oconto R.	Jump R.	Eau Claire R. - Eau Claire Co.	Eau Claire R. - Marathon Co.	Embarass R.	Turtle C.	Couderay R.	Peshtigo R.	Big Rib R.	Rock R.	Trempealeau R.	Kickapoo R.	Waukau C.	Mecan R.	Fox R.	White R.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	5
2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	10	1	0	0	0	0	3	0	0	0	0
13	5	1	2	0	1	0	1	1	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3	3	0	0	0	0	4	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	6	0	0	2	0	0	1	0	0	0	0	0
0	0	1	2	4	0	2	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	0	7	0
8	1	8	5	7	0	0	0	23	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	5	0	0	0	1	0	0	0	0	0	0	0	0
0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	0
0	2	10	0	4	0	0	2	0	1	0	0	0	10	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	7	0	3	0	0	0	4	0	7	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	0	0	0	1	1	4	0	0	5	2	1	0
2	0	10	0	0	0	1	3	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	9	0	0	0	0	2	0	1	6	3	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	15	0	0	3	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	3	0	1	1	2	0	4	0	0	0	17	0	0	0	2

Appendix A. *Continued.*

Family *Genus-species*	Total	Wisconsin R.	St. Croix R.	Sugar R.	Black R.	Chippewa R.	Flambeau R.	Menominee R.	Wolf R.	Pecatonica R.
Heptageniidae *(continued)*										
Stenonema exiguum	90	0	8	37	19	16	0	1	1	0
Stenonema femoratum	2	0	0	0	0	0	1	0	0	0
Stenonema integrum (mexicanum)	21	5	1	0	8	0	0	0	1	0
Stenonema mediopunctatum	99	0	0	0	0	1	18	35	0	0
Stenonema modestum	24	0	1	0	0	0	3	1	4	0
Stenonema pulchellum	9	0	1	0	0	0	1	7	0	0
Stenonema sp.	18	0	2	4	3	2	0	2	0	0
Stenonema terminatum	247	114	20	39	9	30	4	8	0	8
Stenonema vicarium	38	0	0	0	0	0	8	0	5	0
Leptophlebiidae										
Choroterpes basalis	3	0	0	0	0	0	0	0	0	0
Leptophlebia sp.	18	1	2	0	0	0	12	3	0	0
Paraleptophlebia sp.	16	0	0	0	0	0	4	0	2	0
Metretopodidae										
Metretopus borealis	43	0	0	0	1	42	0	0	0	0
Siphloplecton sp.	44	31	3	0	0	0	2	5	1	0
Oligoneuriidae										
Homoeoneuria ammophila	74	0	0	49	25	0	0	0	0	0
Isonychia sayi	10	0	0	0	8	2	0	0	0	0
Isonychia sicca	1	1	0	0	0	0	0	0	0	0
Isonychia sp.	185	18	18	12	68	2	25	9	4	1
Polymitarcyidae										
Ephoron album	42	1	0	10	17	0	0	0	0	0
Ephoron leukon	22	0	0	0	0	0	4	0	0	0
Potamanthidae										
Anthopotamus myops	42	0	0	35	0	0	0	0	0	2
Anthopotamus sp.	5	0	0	0	0	0	1	0	3	0
Anthopotamus verticus	143	0	89	0	0	0	18	24	6	0
Pseudironidae										
Pseudiron centralis	152	20	8	81	24	3	0	0	0	0
Siphlonuridae										
Parameletus chelifer	11	0	2	0	0	0	0	0	9	0
Siphlonurus sp.	260	0	70	0	11	24	32	49	66	0
Ephemerellidae										
Attenella attenuata	13	0	6	0	0	3	0	1	0	0
Danella sp.	4	0	0	0	0	0	0	0	0	0
Ephemerella aurivillii	6	0	5	0	0	0	0	0	0	0
Ephemerella dorothea	25	7	0	0	9	6	3	0	0	0
Ephemerella inermis	1	0	0	0	0	1	0	0	0	0
Ephemerella invaria	47	0	41	0	0	5	1	0	0	0
Ephemerella needhami	76	3	16	4	10	7	0	1	7	0
Ephemerella rotunda	47	0	1	0	0	0	23	0	9	0
Ephemerella rotunda/invaria	15	0	0	0	0	0	0	0	0	0
Ephemerella subvaria	6	0	0	0	0	0	0	3	3	0
Eurylophella aestiva	7	0	0	0	0	0	4	2	0	0
Eurylophella bicolor	17	0	1	0	1	1	1	0	0	0
Eurylophella sp.	2	0	1	0	0	0	1	0	0	0
Eurylophella sp. A	5	0	1	0	0	0	0	0	0	0
Eurylophella temporalis	38	1	10	0	17	4	5	0	1	0
Serratella deficiens	12	0	5	0	0	0	0	0	0	0
Serratella sordida	7	0	0	0	0	0	1	0	0	0
Tricorythidae										
Tricorythodes sp.	125	9	11	21	7	5	0	0	10	0

[a] Now genus *Labiobaetis* per McCafferty and Waltz 1995.

Oconto R.	Jump R.	Eau Claire R - Eau Claire Co.	Eau Claire R - Marathon Co.	Embarass R.	Turtle C.	Couderay R.	Peshtigo R.	Big Rib R.	Rock R.	Trempealeau R.	Kickapoo R.	Waukau C.	Mecan R.	Fox R.	White R.
2	0	0	0	0	0	0	1	0	0	1	4	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0
16	1	0	2	4	7	13	1	0	0	0	0	0	1	0	0
13	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	2	8	0	3	0	2	0	0	0	0	0	0
8	5	0	4	0	0	5	0	3	0	0	0	0	0	0	0
0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	6	2	0	0	0	5	6	0	0	1	0	0	0	0	0
0	0	1	0	0	0	12	0	1	0	0	0	0	0	0	0
0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0
0	0	0	0	2	0	0	0	0	0	14	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	2	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	8	0	0	1	0	0	3	16	0	0	0	0
0	3	0	0	0	0	0	11	0	0	0	0	0	0	0	0
0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	2	0	0	0	0	0	11	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	5	0	0	2	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
0	0	3	0	6	20	0	0	0	33	0	0	0	0	0	0

Appendix B. *Distribution of Trichoptera (caddisflies) collected incidental to the mayfly survey of 1991-93, by river. Taxonomy follows Morse 1993.*

Family *Genus-species*	Total	Wisconsin R.	St. Croix R.	Sugar R.	Black R.	Chippewa R.	Flambeau R.	Menominee R.	Wolf R.	Pecatonica R.
Hydropsychidae										
Cheumatopsyche sp.	49	18	2	3	0	5	2	1	1	0
Ceratopsyche morosa bifida	25	0	17	0	0	0	0	0	3	0
Ceratopsyche walkeri	1	0	0	0	0	0	0	0	0	0
Ceratopsyche alternans	2	0	0	0	0	1	0	0	0	0
Ceratopsyche vexa	1	0	0	0	0	0	0	0	0	0
Hydropsyche orris	22	14	0	0	0	8	0	0	0	0
Hydropsyche bidens	11	0	0	3	8	0	0	0	0	0
Hydropsyche betteni	3	0	0	0	0	0	0	0	0	0
Hydropsyche phalerata	20	0	18	0	0	0	0	1	1	0
Hydropsyche cuanis	1	0	0	0	0	0	0	0	1	0
Hydropsyche placoda	1	0	0	0	0	0	0	0	1	0
Hydropsyche simulans	17	0	0	5	7	1	0	0	0	0
Hydropsyche scalaris	10	0	3	0	0	0	1	0	2	0
Potamyia flava	8	7	0	1	0	0	0	0	0	0
Macrostemum zebratum	7	0	1	0	0	0	3	0	0	0
Philopotamidae										
Chimarra obscura	5	0	0	0	0	0	1	0	0	0
Chimarra socia	2	0	1	0	0	0	0	0	1	0
Polycentropodidae										
Neureclipsis sp.	16	5	0	0	2	1	0	1	1	0
Polycentropus sp.	10	0	3	0	1	2	0	2	0	0
Phylocentropus sp.	2	0	2	0	0	0	0	0	0	0
Psychomyiidae										
Psychomyia flavida	2	0	0	0	0	0	0	0	0	0
Glossosomatidae										
Glossosoma sp.	3	0	1	0	0	0	1	0	1	0
Protoptila sp.	7	0	3	0	0	0	0	0	0	0
Hydroptilidae										
Agraylea sp.	11	5	0	0	0	1	0	0	0	0
Ithytrichia clavata	1	0	0	0	1	0	0	0	0	0
Brachycentridae										
Brachycentrus numerosus	27	3	0	3	12	1	0	0	0	0
Brachycentrus occidentalis	1	0	0	0	0	0	0	0	0	0
Micrasema rusticum	2	0	0	0	0	0	0	0	0	0
Helicopsychidae										
Helicopsyche borealis	22	0	7	0	0	0	3	3	5	0
Lepidostomatidae										
Lepidostoma spp.	10	0	9	0	0	0	0	0	1	0
Leptoceridae										
Ceraclea spp.	15	6	0	1	5	1	0	0	0	0
Leptocerus americanus	2	0	0	0	0	0	0	0	2	0
Nectopsyche sp.	1	0	0	0	1	0	0	0	0	0
Nectopsyche candida	90	36	9	8	16	1	0	0	6	6
Nectopsyche diarina	9	0	0	2	1	2	0	0	0	0
Nectopsyche pavida	6	0	6	0	0	0	0	0	0	0
Oecetis spp.	19	0	7	0	0	0	0	4	2	0
Triaenodes sp.	5	0	5	0	0	0	0	0	0	0
Limnephilidae										
Anabolia sp.	6	0	2	0	0	0	0	0	1	0
Arctopora sp.	1	0	0	0	0	0	0	0	0	0
Ironoquia sp.	1	0	0	0	0	1	0	0	0	0
unidentified Limnephilidae	2	0	0	0	0	0	0	0	0	0
Onocosmoecus unicolor	1	0	0	0	0	0	0	0	0	0
Pycnopsyche spp.	21	3	2	0	0	1	3	1	1	0
Sericostomatidae										
Agarodes distinctus	1	0	1	0	0	0	0	0	0	0
Uenoidae										
Neophylax spp.	9	0	0	0	0	0	6	1	0	0

Oconto R.	Jump R.	Eau Claire R. - Eau Claire Co.	Eau Claire R. - Marathon Co.	Embarass R.	Turtle C.	Couderay R.	Peshtigo R.	Big Rib R.	Rock R.	Trempealeau R.	Kickapoo R.	Waukau C.	Mecan R.	Fox R.	White R.
0	0	3	1	0	2	1	1	0	2	0	0	1	1	4	0
0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0
0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	3	0	0	0	0	0	0	1	0	1	0	1
0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	2	0	0	0	0	0	1	5	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	2	0	0	0	0	0	1	1	0	1	1	0
1	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	1	0	1	1	0	1	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	2	0	0	0	1	2	0	0	0	0	2	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Appendix C. *Distribution of Coleoptera (beetles) collected incidental to the mayfly survey of 1991-93, by river.*

Family *Genus-species*	Total	Wisconsin R.	St. Croix R.	Sugar R.	Black R.	Chippewa R.	Flambeau R.	Menominee R.	Wolf R.	Pecatonica R.
Elmidae										
Ancyronyx variegata	4	0	1	0	0	0	0	1	1	0
Dubiraphia bivittata	1	0	1	0	0	0	0	0	0	0
Dubiraphia minima	31	5	20	2	1	1	0	1	0	0
Dubiraphia quadrinotata	1	0	1	0	0	0	0	0	0	0
Dubiraphia vittata	2	0	0	0	0	0	0	0	2	0
Macronychus glabratus	40	4	4	3	13	0	1	2	0	0
Optioservus fastiditus	4	1	1	0	0	0	0	0	1	0
Optioservus trivittatus	17	0	1	0	0	0	3	0	2	0
Optioservus sp. (unidentified)	3	0	0	0	0	0	2	0	0	0
Stenelmis antennalis	1	0	0	0	0	0	0	0	0	0
Stenelmis bicarinata	70	0	53	0	0	0	1	16	0	0
Stenelmis crenata	43	1	0	1	3	0	8	2	3	0
Stenelmis decorata	12	6	0	2	1	0	0	0	1	2
Stenelmis fuscata?	1	1	0	0	0	0	0	0	0	0
Stenelmis grossa	11	1	4	2	0	0	0	0	0	2
Stenelmis mera	16	0	15	0	0	0	0	0	1	0
Stenelmis sexilineata	1	0	0	0	0	0	0	0	0	0
Stenelmis sp. (unidentified)	7	2	0	0	0	0	2	0	1	0
Dryopidae										
Helichus lithophilus	2	0	1	0	0	0	0	0	1	0
Psephenidae										
Psephenus herricki	12	0	0	0	0	0	0	2	4	0
Hydrophilidae										
Berosus peregrinus	3	1	1	0	1	0	0	0	0	0
Crenitis digesta	1	0	0	0	0	0	0	0	0	0
Enochrus ochraceus	1	0	0	0	0	0	0	0	0	0
Helophorus sp.	1	0	0	1	0	0	0	0	0	0
Hydrochara obtusata	1	0	0	0	0	0	0	0	0	0
Dytiscidae										
Acilius sylvanus	1	0	0	0	1	0	0	0	0	0
Agabus sp.	1	0	0	0	0	0	0	0	1	0
Ilybius sp.	1	0	0	0	0	0	0	0	1	0
Neoporus clypealis	1	1	0	0	0	0	0	0	0	0
Haliplidae										
Haliplus borealis	5	1	3	0	0	0	0	1	0	0
Haliplus immaculicollis	1	0	0	0	0	0	0	0	0	0
Haliplus leopardus	1	0	0	0	0	0	1	0	0	0
Peltodytes duodecimpunctatus	2	0	1	0	0	1	0	0	0	0
Peltodytes edentulus	24	6	9	1	1	4	1	0	1	1
Peltodytes tortulosus	1	1	0	0	0	0	0	0	0	0
Gyrinidae										
Dineutus discolor	13	10	2	0	1	0	0	0	0	0
Gyrinus aeneolus	13	0	12	0	0	0	0	1	0	0
Gyrinus analis	2	0	0	0	0	0	0	0	1	1
Gyrinus ventralis	1	0	0	0	0	0	1	0	0	0

Oconto R.	Jump R.	Eau Claire R. - Eau Claire Co.	Eau Claire R. - Marathon Co.	Embarass R.	Turtle C.	Couderay R.	Peshtigo R.	Big Rib R.	Rock R.	Trempealeau R.	Kickapoo R.	Waukau C.	Mecan R.	Fox R.	White R.
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	2	0	3	0	0	0	1	0	5	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	2	0	1	1	0	1	6	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	3	0	2	3	0	1	7	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	5	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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